Walk-in cooler using a window air conditioner and temperature controller, DIY

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https://sites.google.com/view/low-tech-farm-tools

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Introduction

Vegetables are stored in cool rooms at ~40 F (7C). Window air conditioners for cooling rooms have a factory pre-set cooling temperature limit of 60F (16C). This temperature limit must be overridden to cool a vegetable storage room below 60F (1-6). To override the pre-set cooling temperature limit, relocate the air conditioner temperature sensor and apply heat to the temperature sensor (1-3) so that air conditioner responds to the heated temperature sensor instead of room temperature. When the temperature sensor is heated the air conditioner turns on; when the heater is turned off, the air conditioner turns off. The heater is turned on and off by a temperature controller, set to a target room temperature, below 60F (16C).

During the cooling cycle, ice can form on the air conditioner evaporator fins and blocking air flow, which reduces the rate of air cooling and cause the compressor to overwork. To prevent ice formation on fins, use another temperature controller with its temperature sensor attached to the evaporator fins to turn off the heater at freezing, which turns the air conditioner off and allow ice to thaw. Thus, the heater is controlled by two temperature controllers, one senses room temperature and one senses fin temperature. This method of overriding the pre-set cooling temperature limit is suited for most digital air conditioners but not analog air conditioners (1).

Another way to override the factory pre-set cooling temperature limit is to provide power to the air conditioner compressor through a temperature controller and a relay (3-6). The temperature controller turns the compressor on and off through a relay, and bypasses the air conditioner temperature sensor. The relay protects the temperature controller from power surges to the compressor. To prevent ice formation on evaporator fins, another temperature sensor is attached to the evaporator fins and turns off power to the compressor at freezing to allow ice to thaw. The air conditioner fan is always on; the compressor is switched by two temperature controllers, one for room temperature and another for fin temperature (4, 6). There is no heater for the air conditioner temperature sensor. Rewiring a compressor with temperature controllers to override the cooling temperature limit can be applied to any air conditioners, analog or digital (4).

Note window air conditioner cooling capacity (BTU per hour) should match the application: room size, amount of room insulation, frequency which the door is opened allowing warm air into the room, target temperature of the cool storage room and heat load of products brought into the room for cooling. Lower target room temperature requires larger air conditioner cooling capacity. Larger air conditioners may have a secondary temperature sensor; it is also bundled with the main temperature sensor and heater (1).

This article provides instructions, wire diagrams and photos of a walk-in cooler setup for the do-it-yourselfers.

Method

Here are wiring details for using two Inkbird ITC-308 (Figures 1-6) or two Inkbird ITC-1000 (Figures 7-14) temperature controllers to heat the air conditioner temperature sensor and override the pre-set cooling temperature limit of a digital air conditioner. One temperature controller is set to the desired room temperature; the other temperature controller measures the air conditioner evaporator fin temperature for ice formation (Figure 4). The two temperature controllers are connected in series (Figure 2, 9, and 10); controls power to the heater; the heater heats the air conditioner temperature sensor; which turns on the air conditioner. If room temperature is above the set temperature and there is no ice on the air conditioner evaporator fins, the air conditioner turns on. If room temperature is below set temperature, or the evaporator fin temperature is at freezing the air conditioner turns off.

1. **Using two Inkbird ITC-308 temperature controllers to override the air conditioner cooling temperature limit**

ITC-308 temperature controller comes with power plug and sockets (~$35 each, November 2021).

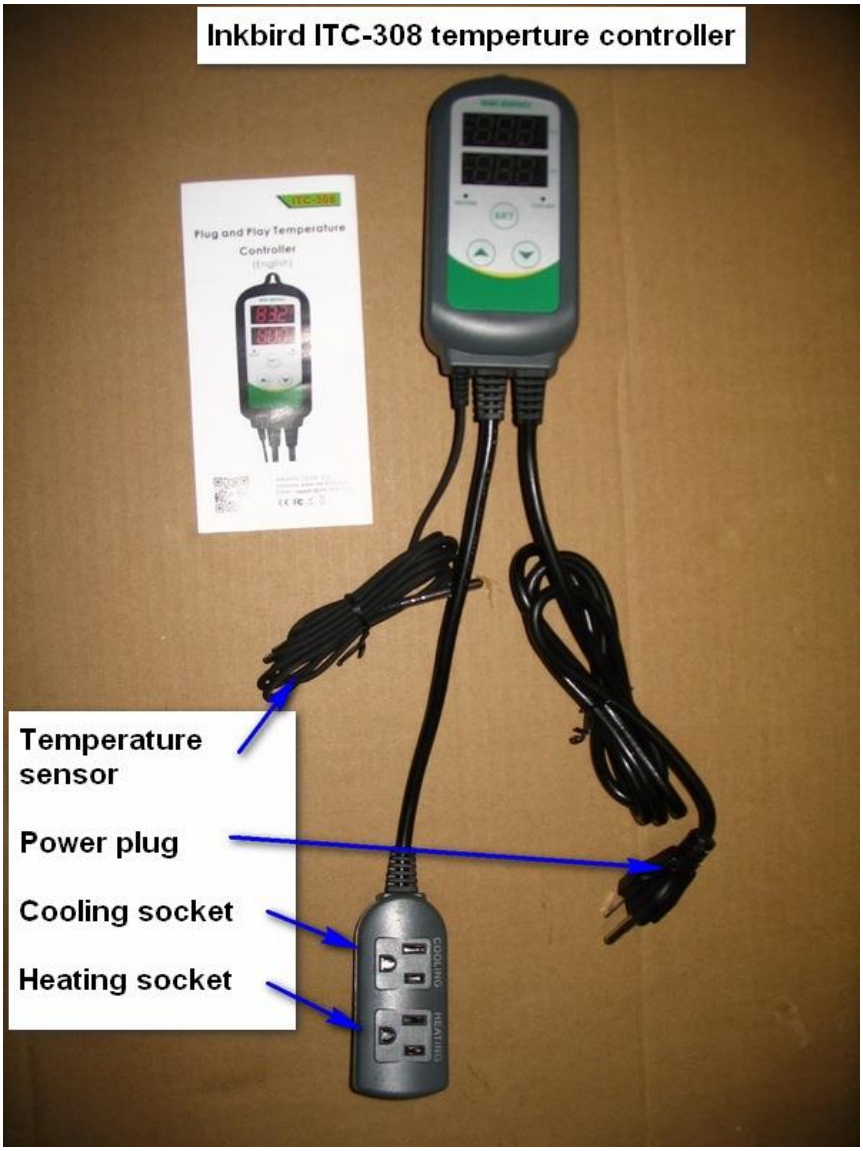

Figure 1. Inkbird ITC-308 temperature controller

Two Inkbird ITC-308 temperature controllers are connected in series to override the air conditioner temperature limit. ITC-308 #1 plugs into AC wall outlet; ITC-308 #2 plugs into ITC-308 #1 cooling socket; a 1-watt heater plugs into ITC-308 #2 cooling socket; the heater heats the air conditioner temperature sensor and turns on the air conditioner.

Figure 2. Two Inkbird ITC-308 temperature controllers connected in series and controls power to a 1-watt heater.

ITC-308 #1

Temperature sensor measures room temperature (or fin temperature)
Power plug connect to 120 VAC power supply
Cooling socket connects to ITC-308 #2 power plug
Heating socket not used

ITC-308 #2

Temperature sensor measures air conditioner fin temperature (or room temperature)
Power plug connect to ITC-308 #1 cooling socket
Cooling socket connects to a 1-Watt heater
Heating socket not used

Heater = 10-33 K ohm resistor, rated at 2-watt heat dissipation

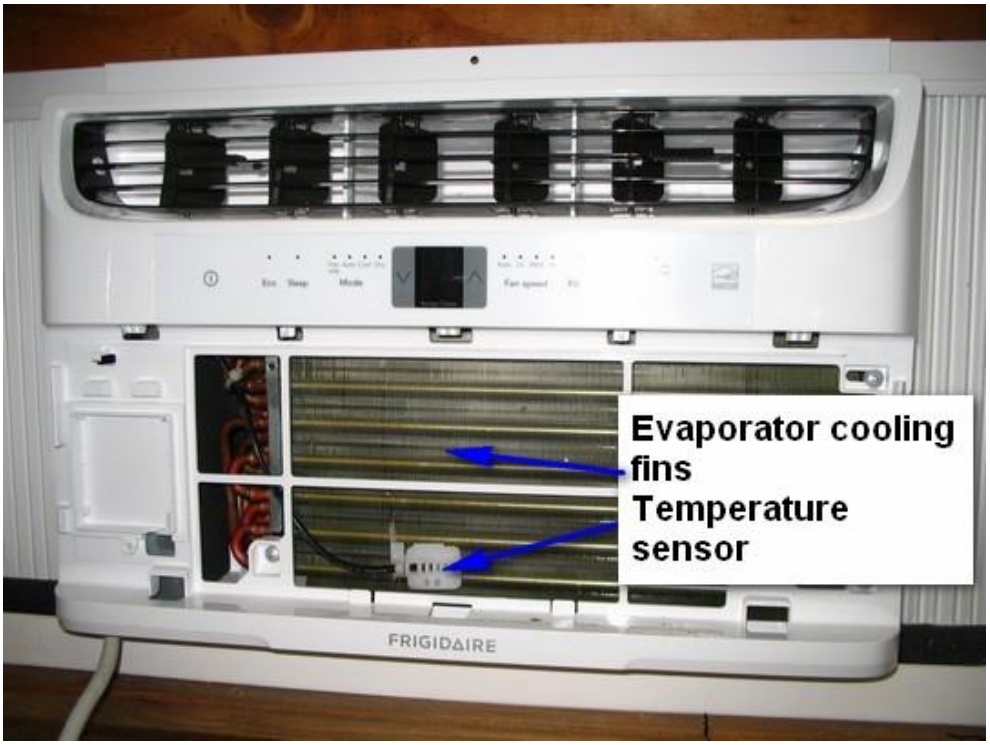

Figure 3. Window air conditioner with front grill removed, revealing air conditioner temperature sensor and evaporator fins

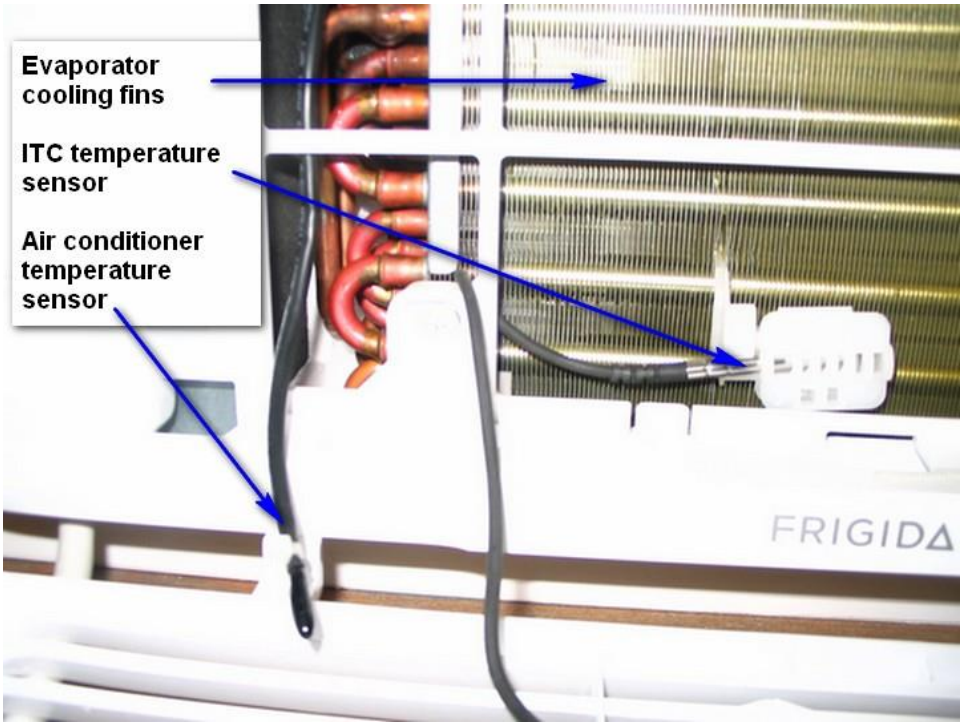

Figure 4. Move air conditioner temperature sensor away from the evaporator fins and replace with ITC-308 temperature sensor

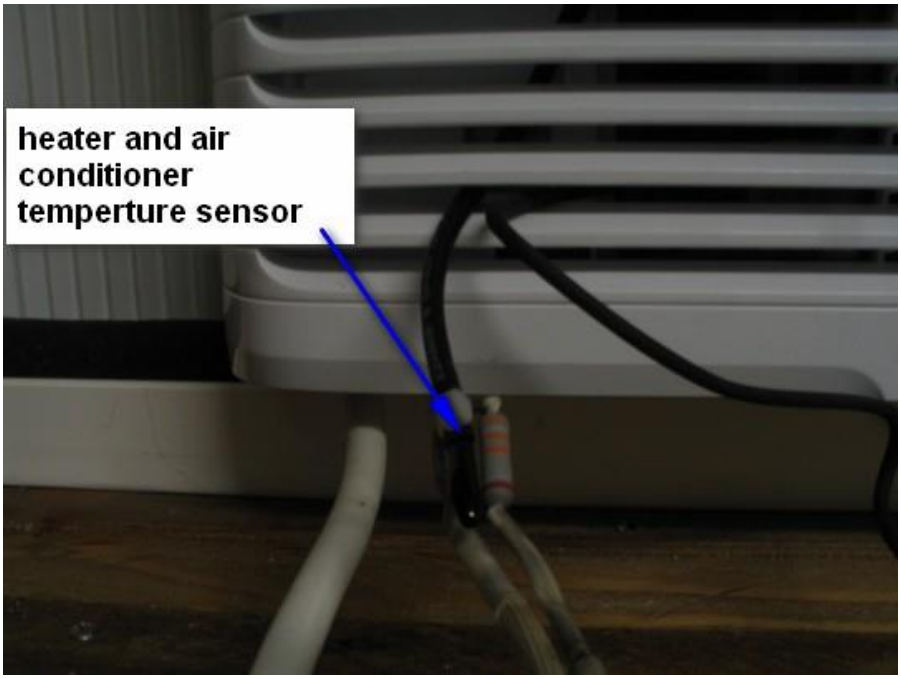

Figure 5. 33K ohm resistor heater (rated at 2-watt heat dissipation) is placed next to air conditioner temperature sensor then wrap both with aluminum foil

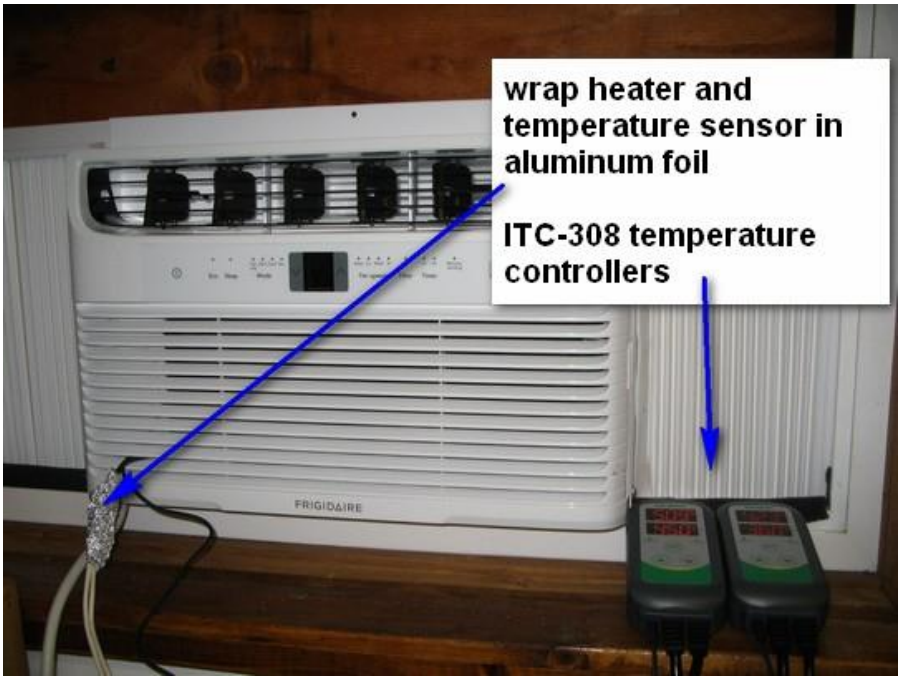

Figure 6. Window air conditioner; heater and air conditioner temperature sensor wrapped in aluminum foil; and two Inkbird ITC-308 temperature controllers.

ITC-308 #1 temperature sensor measures room temperature; ITC-308 #2 temperature sensor measures evaporator fin temperature.

2. **Using two Inkbird ITC-1000 temperature controllers to override the air conditioner temperature limit**

ITC-1000 requires wiring; it does not come with power plug or sockets (~$17 each, November 2021)

Figure 7. Front and back view of ITC-1000 temperature controllers

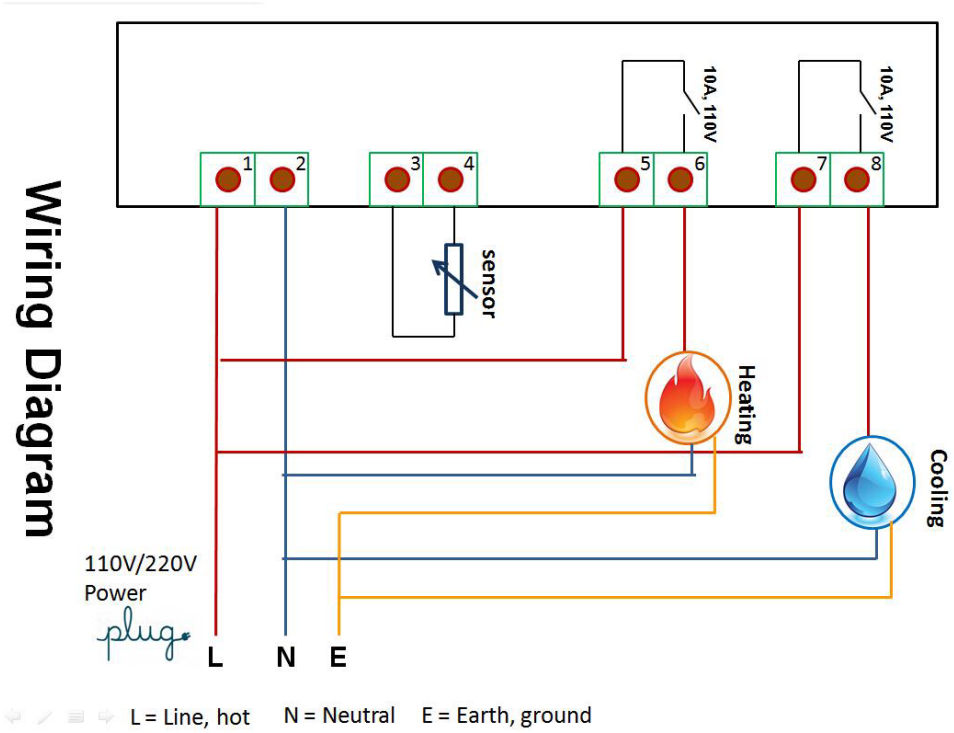

Figure 8. Wire diagram from Inkbird ITC 1000 manual

Wiring option one:

Inkbird ITC-1 switches power to ITC-2; ITC-2 switches power to 1 watt heater; the heater heats the air conditioner temperature sensor and turns on the air conditioner. Power to ITC-1 is always on; power to ITC-2 and heater is switched. This configuration is equivalent to using two ITC-308 temperature controllers shown in Figure 2.

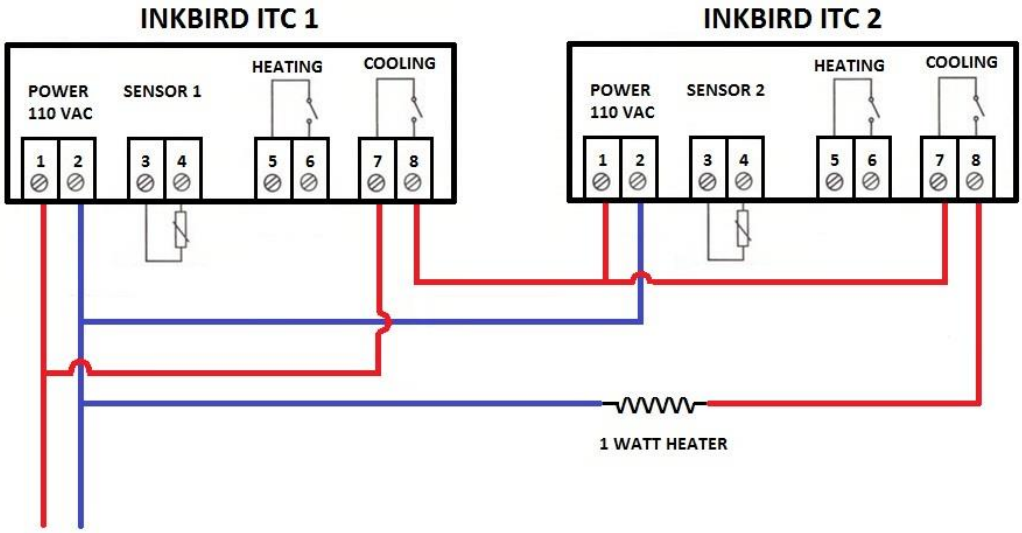

Figure 9. Wire diagram of 1 watt heater connected in series to two ITC-1000 temperature controllers

Red = line, hot
Blue = neutral

ITC 1: when room temperature is greater than set temperature, terminals 7 and 8 close; ITC-1 turns on power to ITC-2. When room temperature is less than the set temperature, terminal 7 and 8 open; ITC-1 turns off power to ITC-2.

ITC 2: when ITC-2 is on, it checks the air conditioner fin temperature. If fin temperature is above freezing, the cooling switch between terminals 7 and 8 close; 1 watt heater turns on. When the air conditioner fins freeze, the cooling switch opens; 1 watt heater turns off.

Sensor 1 = measures room temperature.
Sensor 2 = measures air conditioner fin temperature (location of sensors 1 and 2 can be reversed).

Heater = ~1 watt (1-watt light bulb or 10-33 K ohm resistor on 120 VAC or 100-330 ohm resistor on 12 volt). Heater is in physical contact with the air conditioner temperature sensor, and wrapped together with aluminum foil.

Electricity flows through 1 watt heater when both ITC-1 and ITC-2 circuits are closed. The heater heats the air conditioner temperature sensor and turns on the air conditioner.

Terminals 5 and 6 are not used in cooling configuration.

Wiring option two:

Inkbird ITC-1 switch (terminal 8) connects power to ITC-2 switch (terminal 7), which connects to a 1-watt heater. The heater heats the air conditioner temperature sensor which turns on the air conditioner. Power to ITC-1 and ITC-2 is always on; this allows constant monitor of room and fin temperatures.

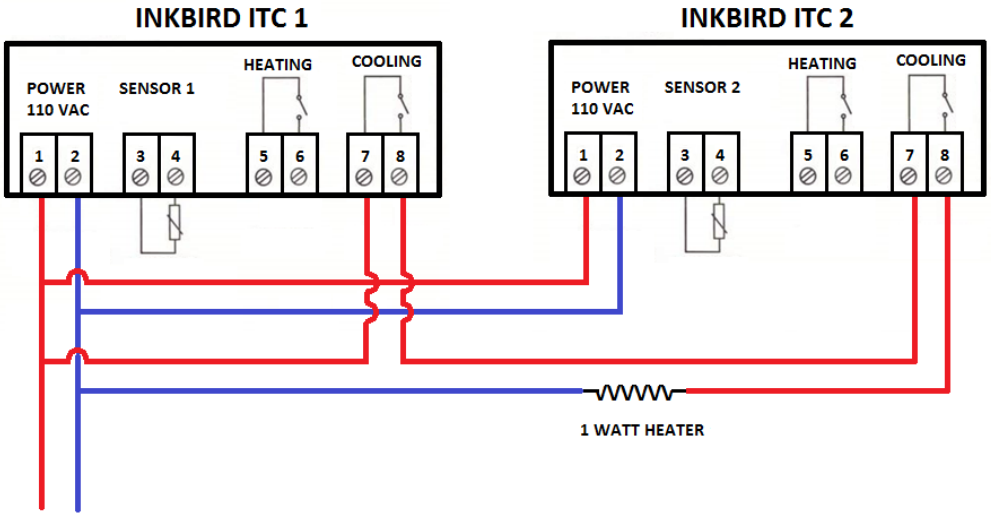

Figure 10. Wire diagram of 1 watt heater connected in series to the cooling switches of two ITC-1000 temperature controllers

Red = line, hot
Blue = neutral

ITC-1: when room temperature is greater than set temperature, terminals 7 and 8 close; hot line connects to ITC-2 cooling switch, terminal 7. When room temperature is less than set temperature, terminals 7 and 8 open; ITC-1 disconnects the hot line to ITC-2 cooling switch, terminal 7.

ITC-2: when air conditioner fin temperature is above freezing, the cooling switch closes. When the air conditioner fins freeze, the cooling switch opens.

Sensor 1 = measures room temperature.
Sensor 2 = measures air conditioner fin temperature (location of sensors 1 and 2 can be reversed).

Heater = ~1 watt (1-watt light bulb or 10-33 K ohm resistor on 120 VAC or 100-330 ohm resistor on 12 volt). Heater is in physical contact with the air conditioner temperature sensor, and wrapped together with aluminum foil.

Electricity flows through the 1-watt heater when both ITC-1 and ITC-2 circuits are closed. The heater heats the air conditioner temperature sensor which turns on the air conditioner.

Terminals 5 and 6 are not used in cooling configuration

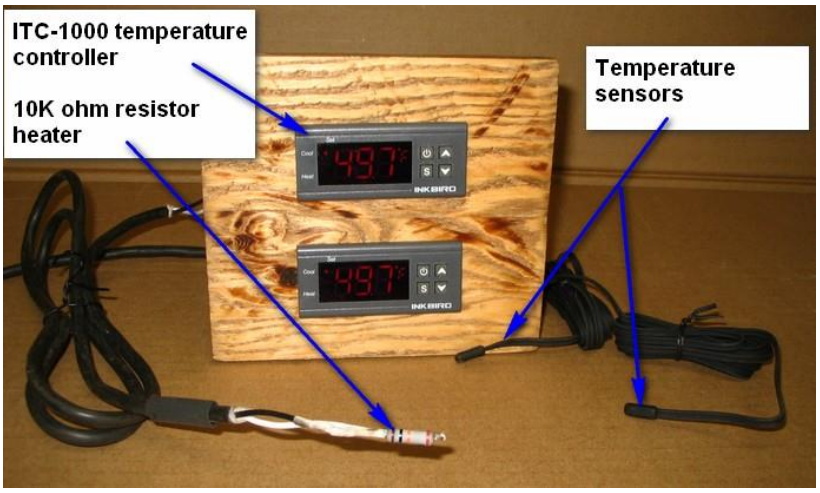

Figure 11. 10K ohm resistor heater and two Inkbird ITC-1000 temperature controllers with temperature sensors.

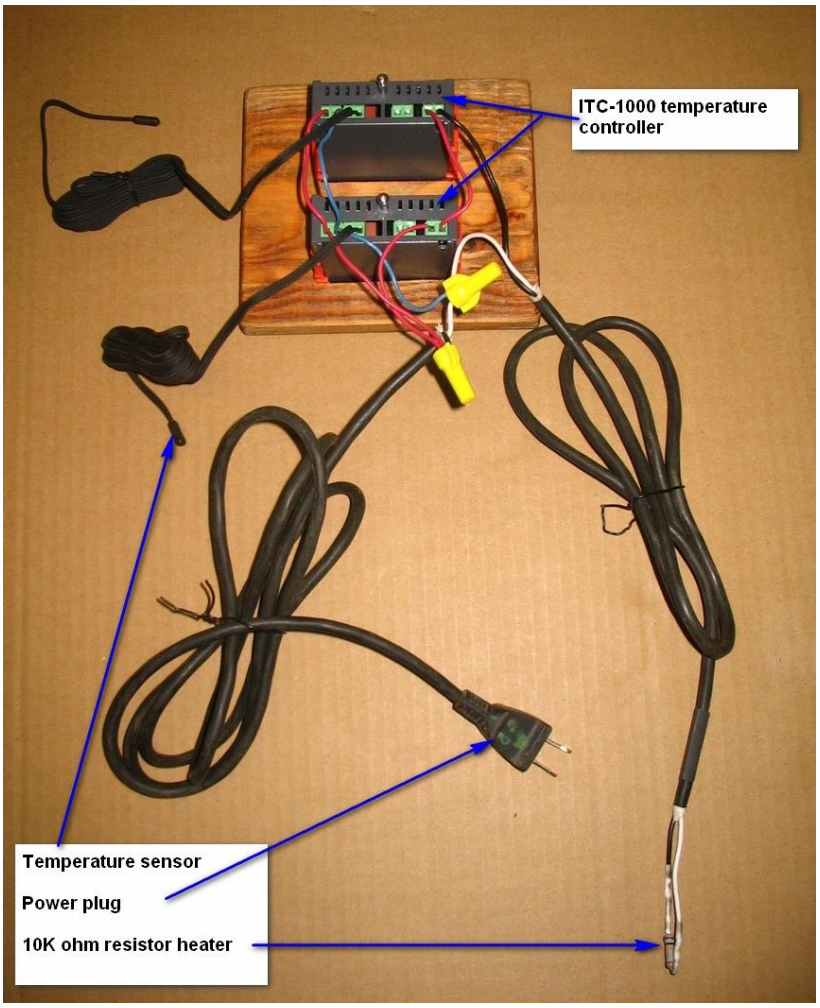

Figure 12. Rear view of ITC-1000 temperature controllers, temperature sensors, 10K ohm resistor heater and power plug

Figure 13. Air conditioner; heater and air conditioner temperature sensor wrapped in aluminum foil; and two Inkbird ITC-1000 temperature controllers. ITC-1000 #1 temperature sensor measures room temperature; ITC-1000 #2 temperature sensor measures evaporator fin temperature.

Remove air conditioner temperature sensor away from the evaporator fins and attach ITC-1000 temperature sensor to evaporator fins as shown in Figure 4. Attach 1 watt heater next to the air conditioner temperature sensor and wrap together in aluminum foil, as shown in Figure 5.

References

1. The website <www.StoreItCold.com> has extensive information on building a walk-in cooler using window air conditioner and a proprietary temperature controller with heater and 2 temperature sensors.

2. The website www.homebrewtalk.com has discussions on using temperature controllers to override the pre-set cooling temperature limit of air conditioners. For example, this thread started by CidahMastah on August 14, 2012 https://www.homebrewtalk.com/threads/347556/

a. H22W on Jun 10, 2014 said "*You put two stc-1000 units in series*'
b. LavaAle on Nov 17, 2015 said '*I used two STC-1000 units, a 5v light bulb and a 5v power supply (old cell phone charger)*'
c. Zazbnf on Mar 31, 2016 said '*I have been running a controller using 2 stc-1000's a 12v wall wort, using a 1W 100 Ohm resistor and a pulse width modulator for the heat source*.'

3. Bobby_M described using ITC-1000 to control the air conditioner compressor; or the alternative option of heating the air conditioner temperature sensor, posted on Sept 7, 2021 at

<https:/www.homebrewtalk.com/threads/override-window-air-conditioner-not-working.6684/post-9158698> '*You would need to put a small low wattage heat source on the AC's built in temp sensor and that heat source would have to be switched by the 7/8 terminal instead. That way when the ITC calls for cooling, it actually heats up the sensor on the AC. Doing it this way will let you run the AC well below it's built in thermostat. Acceptable heat sources would be a small 1 watt light bulb, a very small cartridge heater, A 2 watt resistor rated at 10,000 ohms…* '

4. Durango Doug use two Inkbird ITC-308 controllers and a contact relay to control the air conditioner compressor, posted Dec 7, 2018 at http://www.homebrewtalk.com/threads/323547/ , '*If you wire up to directly control the compressor, you can use any ac unit you want, and there is no on/off delay caused by using a heater on the temp probe. The two inkbird controllers are plugged into each other in series, and control on/off of the compressor.*'

5. NorCal uses a WTS-3A016 temperature controller and relay connected to the compressor to override the temperature limit of the air conditioner, for wine storage, posted on Sept 21, 2014 https://www.winemakingtalk.com/threads/cold-box-wine-storage-project.45815/post-529948 here

6. Archeryrob uses a temperature controller and relay to control air conditioner compressor for meat storage, posted November 7, 2017 here.
https://archeryrob.wordpress.com/2017/11/07/

Acknowledgment
Technical assistance from Larry Fisher, Torema, Davis, California,< http://www.torema.org/>

Note: Mention of manufacture's name is for reader's benefit and does not imply endorsement.